deposition gases, said desired low deposition rate being lower than a deposition rate using said selected deposition gases at said deposition gas flow rates with a lower flow rate of said inert gas; and

means for depositing a thin film on the substrate at said low deposition rate from said reaction of said deposition gases.

C4 CONT

## REMARKS

Claims 1-10 and 44-62 are pending. Claims 1, 3, 44, and 60-62 have been amended to correct informalities. No new matter has been introduced. Applicants believe the claims comply with 35 U.S.C. § 112.

Claim 51 stands rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. The Examiner alleges that the unit "mils" is not an acceptable S.I. standard for a distance. The Examiner is quite right. However, "mils" is widely known as "milli-inches," which is an acceptable unit for a distance in the United States. Thus, claim 51 complies with 35 U.S.C. § 112.

Claims 44 and 45 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Felts et al. (USP 4,888,199).

Applicants respectfully assert that independent claim 44 and claim 45 depending therefrom are novel and patentable over Felts '199 because, for instance, Felts '199 does not teach or suggest computer instructions for controlling the gas delivery system to add a flow of an inert gas to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases, wherein the desired deposition rate is lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas.

The Examiner alleges that Felts '199 anticipates the claimed relationship of deposition rates and the presence of an inert gas in disclosing that "[a]n increase of the inert gas supply provides more electrons, and a decrease in the gas fewer electrons" (col. 10, lines 48-50). The Examiner alleges:

> With the addition of an IG (He) the partial pressures of all "selected deposition gases" will deminish [sic] and effectively "lower" or reduce the deposition rate.

The Examiner's allegation is flawed. Claim 44 recites that the desired deposition rate achieved by adding a flow of the inert gas is lower than a deposition rate using the selected deposition gases at the deposition gas flow rates (which are the same as the deposition gas flow rates to achieve the desired deposition rate) with a lower flow rate of the inert gas. Because the same deposition gas flow rates are used, the partial pressures of the selected deposition gases will <u>not</u> diminish, contrary to the Examiner's mistaken belief.

The Examiner further opines:

> In addition, as discussed by Felts et al (U.S. Pat. 4,888,199), the addition of He increases electron density in the plasma (column 10, lines 47-50) which anticipates the effect of reduced deposition rates considering the fact that these added electrons would effectively shield cations thereby reducing one of the chemical mechanisms of PECVD.

The Examiner's statement is without merit. Felts '199 discloses the use of the average electron temperature of the plasma $T_e$ to diagnose and control the plasma deposition. "The average electron temperature of the plasma affects the film deposition rate and properties of the resulting film, so it is an important piece of information to have in a real time plasma control system." Column 2, lines 47-51.

There is nothing in Felts '199 that suggests "added electrons would effectively shield cations thereby reducing one of the chemical mechanisms of PECVD," as alleged by the Examiner. Nor does Felts '199 suggest controlling the gas delivery system to add a flow of an inert gas to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases, wherein the desired deposition rate is lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas, as recited in claim 44. In contrast, Felts '199 is concerned with achieving a desired average electron temperature of the plasma (col. 2, line 58, to col. 3, line 6):

supported by Puchert et al

> By taking another ratio of two emissions lines, one produced by a species that necessarily absorbs a high energy from electron collisions

with it and another from a species having a probability of having absorbed much lower energy from electron collisions with it to give the measured emission, a declining "tail" of an electron energy (temperature) distribution within the plasma can be monitored and controlled. It has been found that high energy electrons in the plasma can inadvertently be suppressed in the course of optimizing other variables. Therefore, a separate high energy electron density measurement reveals whether this is happening or not and allows an adjustment to be made in real time to maintain a sufficient proportion of high energy electrons in the plasma. An adequate supply of high energy electrons is important to the hardness of the resulting film.

Therefore, claims 44 and 45 are novel and patentable.

Claims 60 and 61 stand rejected under 35 U.S.C. 102(e) and 102(g) as being anticipated by Cheung et al. (USP 5,968,324). Applicants note that the present application is divisional of U.S. Patent Application No. 08/567, 338, now USP 5,968,324. Accordingly, Applicants request withdrawal of the rejections of claims 60 and 61.

Claims 1 and 7 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Felts et al. (USP 5,365,665).

Applicants respectfully submit that independent claim 1 and claim 7 depending therefrom are patentable over Felts '665 because, for instance, Felts '665 does not teach or suggest computer readable program code for causing the gas distribution system to introduce a second process gas comprising He into the chamber to control the deposition rate of the first layer.

The Examiner cites Felts '665 at column 5, lines 13-20, 42 for allegedly anticipating this feature of the claim. Felts '665 merely discloses the use of an inert gas (helium or argon) with an organosilicon compound and oxygen of the gas stream to deposit a film. Nothing in Felts '665 discloses or suggests introducing a process gas comprising He to control the deposition rate of the deposition layer. Thus, claims 1 and 7 are patentable.

cited

Dependent claims 2-6 and 9 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Felts '665 as applied to claim 1, and further in view of Dory (USP 4,877,641). Dory does not cure the defects of Felts '665. Therefore, claims 2-6 and 9 are patentable.

Dependent claims 46-48 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Felts '199 as applied to claims 44 and 45 above, and further in view of Felts '665. As discussed above, Felts '199 fails to teach or suggest computer instructions for controlling the gas delivery system to add a flow of an inert gas to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases, wherein the desired deposition rate is lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas. Felts '665 does not cure this defect. Accordingly, claims 46-48 are patentable.

SAME AS Above

Dependent claims 49-52 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Felts '199 as applied to claims 44-48 above, and further in view of Felts '665 and Dory. As discussed above, Felts '665 and Dory fail to cure the defects of Felts '199. Thus, claims 49-52 are patentable.

Claims 53-59 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Felts '665 as applied to claim 49 above, and further in view of Felts '199 and Dory.

MPEP 2114.

Independent claim 53 is submitted to be patentable because, for instance, the references do not disclose or suggest that a ratio of the selected flow rate of He to the combined flow rate of $SiH_4$ and $N_2O$ is at least 6.25:1 to deposit an antireflective layer on the substrate at a deposition rate which is lower than a deposition rate using the same flow rate of $SiH_4$ and the same flow rate of $N_2O$ with a lower flow rate of He. This feature is completely absent from the cited references.

Independent claim 54 is patentable because, for instance, the references do not teach or suggest computer instructions for controlling the gas delivery system to add a flow of an inert gas to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a reaction of the selected deposition gases, wherein the desired low deposition rate is lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas. As discussed above, Felts '199 merely discloses the use of the average electron temperature of the plasma $T_e$ to diagnose and control the plasma deposition. Felts '665 merely discloses the use of an inert gas (helium or argon) with an organosilicon compound and oxygen of the gas stream to deposit a film. Dory does not cure the defects of Felts '199 and Felts' 665. Accordingly, claim 54 is patentable.

PATENT

Independent claim 55 and claim 56 depending therefrom are patentable because, for instance, the references fail to disclose or suggest means for adding a flow of an inert gas to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from plasma enhanced reaction of the selected deposition gases, wherein the desired low deposition rate is lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas. As discussed above, nothing in the references suggest this feature.

Independent claim 57 and claims 58-59 depending therefrom are patentable because, for instance, the references do not teach or suggest that a ratio of the selected flow rate of He to the combined flow rate of $SiH_4$ and $N_2O$ is at least 6.25:1 to deposit an antireflective layer on the substrate at a deposition rate which is lower than a deposition rate using the same flow rate of $SiH_4$ and the same flow rate of $N_2O$ with a lower flow rate of He. This feature is completely absent from the cited references.

## CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 650-326-2400.

Respectfully submitted,

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**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

IN THE SPECIFICATION:

Page 1, lines 9-11, please replace the paragraph with the following paragraph:

--This application is a divisional of U.S. Application No. 08/672,888, filed June 28, 1996, which is a continuation-in-part patent application of U.S. Application No. 08/567,338, filed December 5, 1995, entitled "Anti-Reflective Coating and Method for Depositing Same."--

IN THE CLAIMS:

1. (Twice amended) A substrate processing system, comprising:

a vacuum chamber;

a substrate supporter, located within the vacuum chamber, for holding a substrate;

a gas manifold for introducing process gases into the chamber;

a gas distribution system, coupled to the gas manifold, for distributing the process gases to the gas manifold from gas sources;

a power supply coupled **[between the substrate supporter and]** to the gas manifold;

a vacuum system for controlling pressure within the vacuum chamber;

a controller, including a computer, for controlling the gas distribution system, the power supply and the vacuum system; and

a memory coupled to the controller comprising a computer readable medium having a computer readable program code embodied therein for directing operation of the substrate processing system, the computer readable program code including:

computer readable program code for causing the gas distribution system to introduce a first process gas comprising a mixture of $SiH_4$ and $N_20$ into the chamber to deposit a first plasma enhanced CVD layer over the wafer; and

computer readable program code for causing the gas distribution system to introduce a second process gas comprising He into the chamber to control the deposition rate of the first layer.

3. (Amended) A substrate processing system as in claim 2 wherein the computer readable program code for causing the gas distribution system to introduce a second process gas comprising He into the chamber controls the chamber pressure at about 1 to 6 torr, the chamber pressure being the pressure inside the chamber.

 

44. (Amended) A substrate processing system, comprising:

a process chamber;

a substrate support, located within the **[vacuum]** <u>process</u> chamber, for supporting a substrate;

a power supply;

a gas delivery system for delivering process gases into the process chamber;

a controller configured to control the power supply and the gas delivery system; and

a memory coupled to the controller comprising a computer readable medium having a computer readable program embodied therein for directing operation of the substrate processing system, the computer readable program including a first set of computer instructions for controlling the gas delivery system to introduce selected deposition gases into the process chamber at deposited gas flow rates, a second set of computer instructions for controlling the gas delivery system to add a flow of an inert gas to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases, the desired low deposition rate being lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas, and a third set of computer instructions for controlling the power supply to supply power to the process chamber to produce a plasma enhanced reaction of the deposition gases in the process chamber to deposit a film at the low deposition rate.

60. (Amended) A substrate processing system comprising:

<u>a substrate processing chamber;</u>

<u>a substrate support, located within the process chamber, for supporting a substrate;</u>

<u>a gas delivery system for delivering process gases into the substrate processing chamber;</u>

means for forming an antireflective layer over a layer on **[a]** <u>the</u> substrate by flowing selected deposition gases into **[a]** <u>the</u> substrate processing chamber at deposition gas flow rates and adding a flow of an inert gas to the selected deposition gases to deposit the antireflective layer at a desired deposition rate which is lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas;

means for forming a layer of photoresist on the antireflective layer, the antireflective layer having a thickness and refractive indices such that a first reflection from an interface between

the photoresist and the antireflective layer of an exposure light will be an odd number which is at least 3 multiplied by 180° out of phase with a second reflection from an interface between the antireflective layer and the substrate layer of the exposure light; and

means for forming a photoresist pattern by exposing the photoresist layer to the exposure light and developing the exposed photoresist layer.

61. (Amended) A substrate processing system comprising:

a substrate processing chamber;

a substrate support, located within the process chamber, for supporting a substrate;

a gas delivery system for delivering process gases into the substrate processing chamber;

means for forming an SiON antireflective layer over a first layer on **[a]** the substrate by flowing selected deposition gases into **[a]** the substrate processing chamber at deposition gas flow rates and adding a flow of an inert gas to the selected deposition gases to deposit the SiON antireflective layer at a desired deposition rate which is lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas, said antireflective layer having a refractive index in the range of 1.7-2.9, an absorptive index in the range of 0-1.3, and a thickness in the range of 200-3000 angstroms;

means for forming a layer of photoresist over the antireflective layer; and

means for forming a photoresist pattern by exposing the photoresist layer to an exposure light having a wavelength of 365 nm or less and developing the exposed photoresist layer, wherein a phase shift of an odd multiple of at least 3 multiplied by 180° exists between a first reflection of the exposure light from an interface between the photoresist layer and the antireflective layer and a second reflection of the exposure light from an interface between the antireflective layer and the first layer, the first reflection having almost the same intensity as the second reflection to thereby substantially cancel the first and second reflections.

62. (Amended) A substrate processing system comprising:

a substrate processing chamber;

a substrate support, located within the process chamber, for supporting a substrate;

a gas delivery system for delivering process gases into the substrate processing chamber;

means for flowing selected deposition gases into **[a]** <u>the</u> substrate processing chamber at deposition gas flow rates;

means for adding a flow of an inert gas to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a reaction of the selected deposition gases, said desired low deposition rate being lower than a deposition rate using said selected deposition gases at said deposition gas flow rates with a lower flow rate of said inert gas; and

means for depositing a thin film <u>on the substrate</u> at said low deposition rate from said reaction of said deposition gases.